Forest Service

Log Grades

for

Southern Pine

by

Robert A. Campbell

FOREWORD

In addition to a historical summary of southern pine log grading during the past 30 years, this paper presents specifications for grading southern pine logs. Yield and overrun tables are included, and finally the usefulness of the quality index concept is explained and demonstrated.

Southeastern Forest Experiment Station Paper 156, entitled "A Guide to Grading Features in Southern Pine Logs and Trees," contains illustrations and descriptions of the various types of defects referred to in the grading specifications in the present paper. Therefore, when pine log grades are being studied and applied, Station Paper 156 should be used in conjunction with this one.

CONTENTS

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INTRODUCTION

Wood users have long recognized and evaluated differences in timber quality of southern pine. However, the many concepts of quality were based largely on individual experience. This varied concept of timber quality and the absence of a general system or systems for measuring it existed until the 1930's.

In that decade, the Forest Products Laboratory and its cooperators made a start toward the development of grading systems by conducting several pine yield studies. Notable among these early studies were those conducted by Garver et al. (1931) and Reynolds et al. (1944). By the midforties, three southern pine log grading systems (Crossett, Southern Pine Association, and Schlatter) had emerged. In 1949, two additional grade yield studies conducted by the Southeastern Station in South Carolina and Georgia provided the basis for a new system of grading pine logs. This system was tested against the three systems mentioned above and found to be superior. Test results were published in 1953 as "Interim Log Grades for Southern Pine" (U. S. Forest Service 1953), but these were not officially accepted because of limited location and species coverage. Hence more studies were required.

The U. S. Forest Service became the principal user of the interim grades; in the National Forests they were used primarily for making appraisals; the research branch found them useful in forest survey, management, and utilization work. The interim grades performed well in segregating logs into separate value classes, in determining the present value and the economic maturity of pine trees, in determining alternate product use such as saw logs versus pulpwood, also in guiding milling practices, and in segregating cut logs into value classes for selling or buying purposes.

However, the interim studies included only two species and two areas, and so further tests by area and species were necessary. For this reason, three studies were conducted in 1956, including old and second growth Arkansas shortleaf, forest and old field Mississippi loblolly, and north Florida slash and longleaf.

The principal positive results of these three studies were processed tables of overruns and grade yields. Although these were never published, the analysis uncovered several unexplainable species-location differences pointing to the need of a new formal study including logs from the original five sources. Unlike the sawing procedure in earlier studies, however, all logs would be sawed at the same mill by the same sawyer, and the lumber graded by the same Southern Pine Inspection Bureau inspector.

In general, the results of the study conducted in 1959 were similar to those of the 1956 study. Analysis of the data from all studies failed to improve on the predicting estimates of the interim grades proposed in 1953. Hence, on a basis of these findings, the Forest Service Log Grade Committee in 1961 approved the interim log grades and made them the standard southern yellow pine log grades for the U. S. Forest Service.

The present paper would normally have been published then or in 1962. But because a companion volume illustrating and describing the log grading features which are a part of the standard specifications was already well along, it was published first--as Southeastern Forest Experiment Station Paper 156 (Campbell 1962). That booklet contains pictures and descriptions of degrading features, such as knots and conks; also non-degrading scaled features, such as crook and fork, together with unscaled features such as compression wood, pitch soak, stain, etc. By contrast, the present writeup translates these features into log grades and resulting lumber yields.

The first portion of this paper deals with the log grading procedure and explains in detail the purpose of grading, the principles involved, the specifications, and how they are applied. The second item of importance concerns lumber yields by log grade and size. These yields are expressed in percent (of total log yield) by each of the lumber grades found in these major southern pine species. Percentage overruns for logs of various sizes studied (6 to 24 inches) and for each of the three major scaling rules are also indicated in graphic and in tabular form. And finally, the quality index concept as a useful research tool in log grading and evaluation is discussed and brought up to date.

GRADING PROCEDURE

General Considerations

These grades apply to fresh-cut longleaf, shortleaf, slash, and loblolly pine logs. They are based on the external surface characteristics of these species--more specifically, on the aggregate number and size of various kinds of knots relative to log diameter, with sweep, evidence of decay, and excessive dispersion of large or unsound knots acting as degrading factors.

These log grades are designed to show differences in potential value or lumber grade yields when groups of logs are sawn into yard lumber that is graded by the Southern Pine Inspection Bureau Rules. Grading southern pine logs on this basis depends largely on log diameter and the aggregate size and number of knots present. Log lengths must conform with local demands, but since random length lumber ranging from 8 to 20 feet long satisfies most orders for standard length yard lumber, log length has little utility in differentiating the value of yard lumber outturn from different logs with identical diameters and knot patterns. Hence, size and/or number of knots admitted in a given grade of yard lumber (except in B&B) depends on width of piece but not its length.

Each log is graded on its own external surface characteristics and not on those of adjoining logs in a tree or on an estimation of its lumber grade output.

Because logs are graded on external surface characteristics, these grades can be applied to standing live trees as well as to cut logs. This is particularly true because of the insensitivity of the grades to length between 8 and 20 feet. Yard lumber logs shorter than 8 feet are outside the scope of these grades; so also are those longer than 20 feet except when graded as two or more pieces.

Research has shown that the best and most consistent results are obtained when all four log faces are graded. Hence these log grades require the application of the specifications to all four log faces.

Definitions and Measurements

Log. --Any tree section between 8 and 20 feet long (plus trim), measuring at least $4\frac{1}{2}$ inches in diameter at the small end. [1]

Log face. --A portion of the log surface equal to one-fourth the circumference extending full length of the log (each log has four faces).

Quarter face. --A portion of the log surface equal to one-fourth the circumference extending one-fourth the log length. A quarter-face area can be outlined anywhere on a log.

D. --Average diameter at small end of log inside bark to nearest whole inch, usually called "scaling diameter."

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[1] In addition, Forest Service practice requires a log to be at least one-third sound.

Log knot. --Any visible branch, stub, or socket over $\frac{1}{2}$ inch in average diameter, or evidence thereof. Diameter of log knots is measured to the nearest average whole inch outside bark at junction of limb with collar, or the outside complete limb growth ring if limb is cut flush with log surface. Illustrations of this defect and other grading features discussed on this page are shown in Station Paper 156.

    a. Sound: any log knot which does not contain advance decay or does not contain a hole larger than $\frac{1}{4}$ inch in diameter and extending into the log 2 or more inches.

    b. Unsound: any log knot containing advance decay or a hole larger than $\frac{1}{4}$ inch in diameter and 2 or more inches deep.

    c. Overgrown: any log knot buried below the bark surface but indicated by a disturbance of the bark pattern.

    d. Oversize: any sound log knot with diameter larger than D/6.

K count. --A numerical log knot factor used in association with log diameter for placing a log in its tentative grade; it is the number of visible overgrown log knots, plus the sum of average diameters of sound log knots, plus twice the sum of the average diameters of unsound log knots.

Sweep. --The general deviation of the longitudinal log axis from a straight line connecting geometric centers of the log ends. It is measured to the nearest whole inch at the point of greatest deviation. Sweep must measure 3 inches and equal or exceed D/3 to constitute a defect.

Procedures and Specifications

Southern pine logs are graded in two steps. First they are given a tentative grade based on diameter and K count; secondly, they are given a final grade based on other degrading factors. Step 1 consists of determining D and total K count on all four faces. Establish a tentative grade according to the following tabulation:

Grade	Minimum scaling diameter (D) (Inches)	Maximum knot count (K)
I	17	D/5
II	10	D/2
III	5	no limit
IV	5	no limit

As step 2, determine in the sequence listed:

Sweep. --Degrade any tentative I, II, or III grade log one grade if sweep is at least 3 inches and equals or exceeds D/3. (This is the final grade if the log has no evidence of heart rot and no rotten or oversize knots.)

Heart rot. --Degrade any tentative I, II, or III grade log one grade if conk, massed hyphae, or other evidence of advanced heart rot is found. (This is the final grade if the log has no unsound or oversize knots.)

Unsound or oversize knots. --Degrade any tentative grade III log to grade IV if unsound or oversize knots are dispersed so that they cannot be contained in one quarter face.

GRADE YIELDS OF SOUTHERN PINE LOGS

Current grade yield data were developed from some 1,681 logs representing both the 1956 and 1959 studies. The lumber yields include 2-inch dimension material, but stress grade material was not so identified.

At first, sound and defective logs were analyzed separately. This separation reduced some variances and eliminated some of the questionable results of the earlier studies. However, because of the small amount of defect found in the study logs and because defective logs are included in appraisals, the final yield tables include both sound and defective logs.

Lumber grade yields by species were analyzed separately. Because of similarities in yields within log grades and diameter classes, it was possible to combine slash and longleaf into one yield table and loblolly and shortleaf into another. (See tables 1 and 2.) Because of differences between these two groups, especially in regard to yields of the valuable select grades, it was considered advisable to maintain these species groups and not combine them further. These species group differences are quite evident in figure 1.

Since both slash and longleaf were sampled at one Florida location, there was no opportunity to study location differences. On the other hand, an analysis of shortleaf and loblolly logs from Arkansas and Mississippi revealed no appreciable yield differences due to location. No difference due to condition class was found for slash versus longleaf, since all logs were from a single uniform location. Yields of shortleaf and loblolly logs, however, differed significantly by condition class. Old growth shortleaf and forest grown loblolly logs were generally of higher value than those of second growth shortleaf and old field loblolly. Consequently, grade I is composed largely of the former, whereas the second growth and old field logs were, for the most part, relegated to the lower grades.

So few slash and longleaf logs over 17 inches d.i.b. were found in these studies that no yield table for grade I logs was developed. Furthermore, grade II is composed largely of slash pine, but the bulk of the longleaf falls into grades III and IV. Yields of select grades of lumber from grade II slash pine logs were the highest of any southern pine species studied to date. Yields of D select and better lumber averaged over 55 percent of the total. In contrast, grade I logs of the loblolly-shortleaf group averaged less than 50 percent in the same upper lumber grades (see fig. 1).
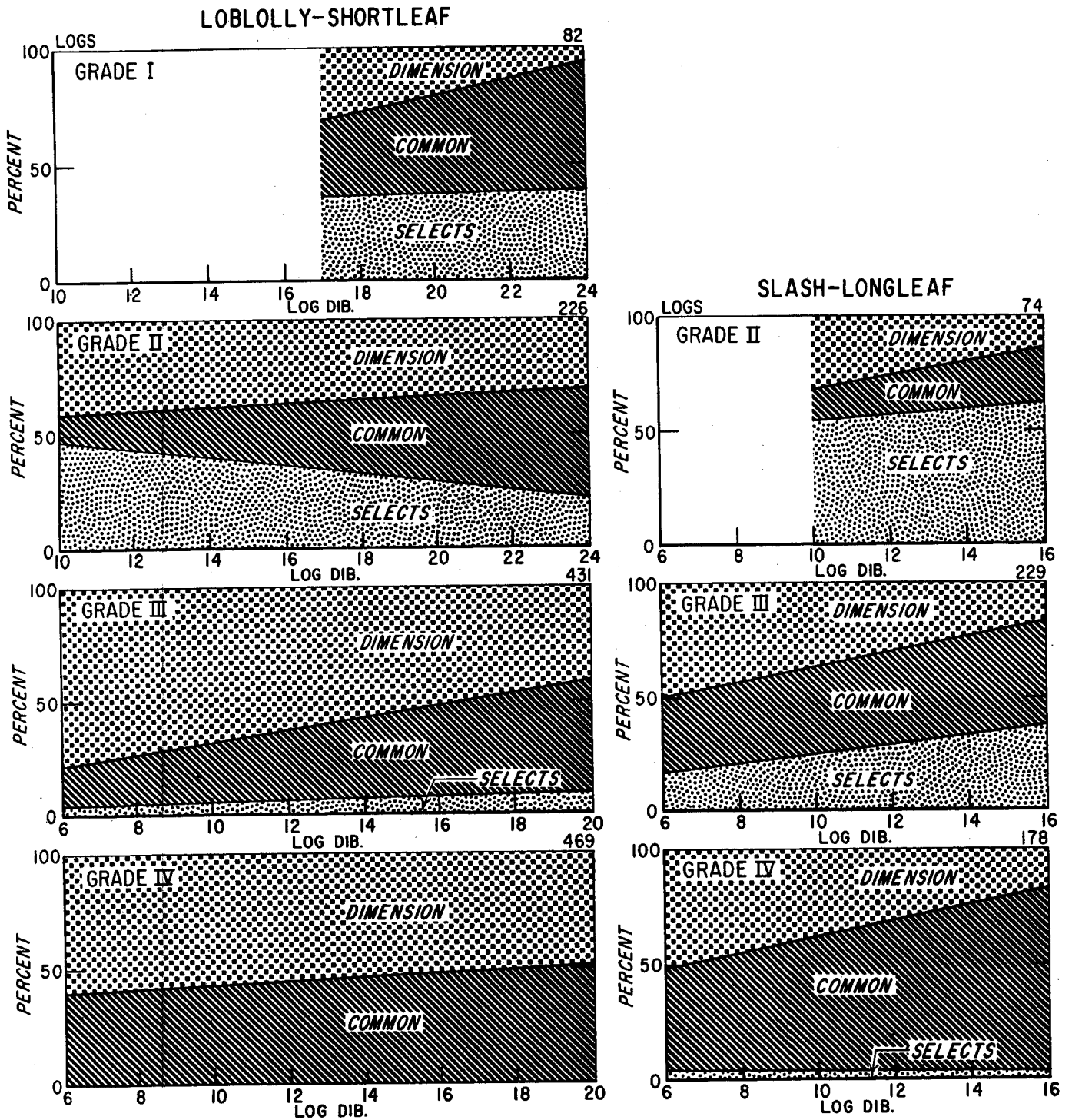
Figure 1. --Southern pine green lumber yield by log grade. All logs from 1956-1959 data. These graphs illustrate the reasons for keeping the yields by species groups separate. Note the large proportion of high-value selects in the slash-longleaf group of grade II logs in contrast to that for the loblolly-shortleaf group.

Table 1. --Green lumber yields for slash and longleaf logs [1]

LOG GRADE II

Log d.i.b. (inches)	Lumber grades									Logs
	B&B	C	D and/or 1C	1D	2C	2D	3C	3D	4C	
	- - - - - - - - - - - - - - - - Percent - - - - - - - - - - - - - - - -									Number
10	9	22	31	25	8	3	2	0	0	15
11	11	22	30	23	9	3	2	0	0	3
12	14	21	28	22	10	3	2	0	0	19
13	17	20	27	21	11	2	2	0	0	11
14	20	20	26	19	12	1	2	0	0	15
15	22	20	24	17	14	1	2	0	0	9
16	25	18	23	16	16	0	2	0	0	2
Average	17	20	26	22	11	2	2	0	0	

LOG GRADE III

Log d.i.b. (inches)	B&B	C	D and/or 1C	1D	2C	2D	3C	3D	4C	Logs
6	1	6	12	32	30	18	1	0	0	30
7	1	7	13	30	31	17	1	0	0	27
8	2	7	14	27	33	16	1	0	0	26
9	2	8	15	25	34	15	1	0	0	35
10	3	8	17	22	35	14	1	0	0	23
11	3	9	18	20	36	13	1	0	0	26
12	4	9	19	17	38	12	1	0	0	27
13	4	10	20	15	40	10	1	0	0	19
14	5	10	21	12	42	9	1	0	0	10
15	5	11	22	10	43	8	1	0	0	5
16	6	11	24	7	44	7	1	0	0	1
Average	4	9	17	18	39	12	1	0	0	

LOG GRADE IV

Log d.i.b. (inches)	B&B	C	D and/or 1C	1D	2C	2D	3C	3D	4C	Logs
6	0	1	3	10	43	38	0	5	0	12
7	0	1	3	9	47	35	0	5	0	32
8	0	1	3	9	50	32	0	5	0	32
9	0	1	3	8	53	29	1	5	0	36
10	0	1	3	7	57	26	1	5	0	34
11	0	1	3	6	60	23	2	5	0	16
12	0	1	3	6	65	18	2	5	0	10
13	0	1	3	5	70	14	2	5	0	3
14	0	1	3	4	73	11	3	5	0	2
15	0	1	3	4	77	7	3	5	0	1
16	0	1	3	3	80	4	4	5	0	0
Average	0	1	3	7	57	25	2	5	0	

[1] Based on curved data from 1956-1959 studies.

Slash and longleaf grades III and IV contained adequate samples of each species, with a total of 229 logs in the former and 178 logs in grade IV. Actually, it was the similarity of slash and longleaf yields, analyzed separately, in these grades that dictated one yield table for both.

Grade I loblolly-shortleaf logs performed as expected, increasing yields in the better lumber grades with increasing log diameter. Log grades III and IV resulted in definite but different yield trends from those expected. Grade III yields increased in the better grades with an increase in diameter. However, grade IV yields averaged only 3 percent in the select grades and did not increase with log diameter. Accordingly, a significant value difference exists between the two grades.

Table 2. --Green lumber yields for loblolly and shortleaf logs [1]

LOG GRADE I

Log d.i.b. (inches)	Lumber grades										Logs
	B&B	C	D and/or 1C	1D	2C	2D	3C	3D	4C	4D	
	- - - - - - - - - - - - - - - - - - - Percent -										Number
17	22	8	18	18	15	9	6	4	0	0	23
18	24	8	18	17	15	8	6	4	0	0	20
19	25	8	18	15	16	7	7	4	0	0	14
20	26	8	19	14	16	6	7	4	0	0	5
21	27	8	19	12	17	5	8	4	0	0	8
22	28	8	20	11	17	4	8	4	0	0	8
23	30	8	20	8	18	3	9	4	0	0	3
24	31	8	21	7	18	2	9	4	0	0	0
25	32	8	21	5	19	1	10	4	0	0	0
26	34	8	22	3	19	0	10	4	0	0	1
Average	25	8	20	12	17	6	8	4	0	0	

LOG GRADE II

Log d.i.b. (inches)	B&B	C	D and/or 1C	1D	2C	2D	3C	3D	4C	4D	Logs
10	20	11	20	25	11	8	1	3	1	0	21
11	20	10	20	25	12	8	1	3	1	0	15
12	19	10	20	24	13	8	2	3	1	0	32
13	19	10	20	24	13	8	2	3	1	0	19
14	18	9	20	24	14	8	3	3	1	0	41
15	18	9	20	23	14	8	4	3	1	0	32
16	18	9	20	23	14	8	4	3	1	0	36
17	17	9	20	23	14	8	5	3	1	0	10
18	17	8	20	22	15	8	6	3	1	0	7
19	16	8	20	22	16	8	6	3	1	0	6
20	16	8	19	21	17	8	7	3	1	0	3
21	16	8	19	21	17	8	7	3	1	0	0
22	15	7	19	21	18	8	8	3	1	0	2
23	15	7	19	20	19	8	8	3	1	0	0
24	14	7	19	20	19	8	9	3	1	0	2
Average	17	9	19	23	15	8	5	3	1	0	

[1] Based on curved data from 1956-1959 studies.

Table 2. --Green lumber yields for loblolly and shortleaf logs [1] (continued)

LOG GRADE III

Log d.i.b. (inches)	Lumber grades										Logs
	B&B	C	D and/or 1C	1D	2C	2D	3C	3D	4C	4D	Number
	- - - - - - - - - - - - - - - - Percent -										
6	1	3	4	46	8	28	3	6	1	0	31
7	1	3	5	43	10	28	3	6	1	0	24
8	2	3	5	40	12	28	3	6	1	0	35
9	2	3	6	37	14	28	3	6	1	0	34
10	3	3	6	34	16	28	3	6	1	0	34
11	3	3	7	31	18	28	3	6	1	0	42
12	4	3	7	28	20	28	3	6	1	0	60
13	4	3	8	25	22	28	3	6	1	0	37
14	5	3	8	22	24	28	3	6	1	0	48
15	5	3	9	19	26	28	3	6	1	0	26
16	6	3	10	16	27	28	3	6	1	0	23
17	6	3	11	13	29	28	3	6	1	0	16
18	6	3	12	10	31	28	3	6	1	0	10
19	7	3	12	7	33	28	3	6	1	0	4
20+	7	3	13	4	35	28	3	6	1	0	7
Average	5	3	10	21	23	28	3	6	1	0	

LOG GRADE IV

Log d.i.b. (inches)	B&B	C	D and/or 1C	1D	2C	2D	3C	3D	4C	4D	Number
6	1	1	2	6	26	38	4	21	0	1	23
7	1	1	2	6	26	37	5	21	0	1	31
8	1	1	2	5	26	37	6	21	0	1	57
9	1	1	2	5	26	36	7	21	0	1	66
10	1	1	2	4	26	36	8	21	0	1	68
11	1	1	2	4	26	35	8	21	1	1	47
12	1	1	2	3	26	35	9	21	1	1	34
13	1	1	2	3	26	34	9	21	2	1	42
14	1	1	2	2	26	34	10	21	2	1	28
15	1	1	2	2	26	32	11	21	3	1	21
16	1	1	2	2	26	32	11	21	3	1	23
17	1	1	2	1	26	31	12	21	4	1	5
18	1	1	2	1	26	31	12	21	4	1	10
19	1	1	2	0	26	30	13	21	5	1	2
20+	1	1	2	0	26	30	13	21	5	1	4
Average	1	1	2	3	26	32	11	21	2	1	

[1] Based on curved data from 1956-1959 studies.

The yields of grade II loblolly-shortleaf logs raised serious questions. Instead of increasing, the yields of the better lumber grades decreased with increasing log size. A close look at the grading specifications reveals a logical explanation for this occurrence. Logs must be 17 inches to qualify for grade I. Thus, most of the good large logs are in grade I, and the large logs in grade II are composed of rejects. Smaller logs (10 to 17 inches) even though surface clear do not qualify for grade I, and consequently the best fall into grade II. This set of conditions explains why the grade II loblolly-shortleaf selects in figure 1 run high in the smaller log sizes and low in the larger. This is one of the arbitrary features that should be recognized in these southern pine log grades.

To this point grade yields have been limited to green lumber. Dry lumber yields have also been computed and are shown in tables 3 and 4. They are based on grade changes observed in the three 1956 yield studies. The conversion factors have been programed for electronic data processing.

Table 3. --Dry lumber yields for slash and longleaf logs[1]

LOG GRADE II

Log d.i.b. (inches)	Lumber grades										Logs
	B&B	C	D and/or 1C	1D	2C	2D	3C	3D	4C	Mfg. loss	
	- - - - - - - - - - - - - - Percent - - - - - - - - - - - - - - - - - -										Number
10	18	13	22	21	14	6	3	1	0	2	15
11	19	13	21	20	14	6	4	1	0	2	3
12	21	13	21	18	14	5	5	1	0	2	19
13	23	13	20	17	14	5	5	1	0	2	11
14	25	13	19	15	14	5	6	1	0	2	15
15	26	13	19	14	14	4	7	1	0	2	9
16	28	13	19	13	14	3	7	1	0	2	2
Average	23	13	20	17	14	5	5	1	0	2	

LOG GRADE III

Log d.i.b. (inches)	B&B	C	D and/or 1C	1D	2C	2D	3C	3D	4C	Mfg. loss	Logs
6	5	4	10	27	23	19	6	4	0	2	30
7	5	5	11	25	25	18	6	3	0	2	27
8	6	5	12	23	26	16	7	3	0	2	26
9	7	5	12	21	27	16	7	3	0	2	35
10	8	6	14	18	28	14	7	3	0	2	23
11	8	6	15	17	29	13	7	3	0	2	26
12	9	7	15	14	31	12	8	2	0	2	27
13	10	7	16	13	32	10	8	2	0	2	19
14	11	8	17	10	33	9	8	2	0	2	10
15	11	8	18	9	34	8	9	1	0	2	5
16	12	8	19	6	36	7	9	1	0	2	1
Average	9	6	15	15	31	12	8	2	0	2	

LOG GRADE IV

Log d.i.b. (inches)	B&B	C	D and/or 1C	1D	2C	2D	3C	3D	4C	Mfg. loss	Logs
6	2	1	6	11	30	33	7	8	0	2	12
7	2	1	6	10	33	31	7	8	0	2	32
8	2	1	6	10	35	29	8	7	0	2	32
9	2	1	6	9	37	26	9	7	1	2	36
10	2	1	7	8	40	23	10	6	1	2	34
11	2	1	7	7	43	20	11	6	1	2	16
12	2	1	8	6	46	17	12	5	1	2	10
13	2	1	8	5	50	13	13	5	1	2	3
14	2	1	8	4	52	11	14	5	1	2	2
15	2	2	9	4	54	8	14	4	1	2	1
16	2	2	9	3	56	5	16	4	1	2	0
Average	2	1	7	8	40	22	11	6	1	2	

[1] Based on curved data from 1956-1959 studies.

Since the grade yields shown in the accompanying tables are southwide averages, local mill scale studies should be used to get an unbiased estimate of the averages by log grade and size for a specific locality. Aggregate lumber tallies by grade, thickness, and width of lumber sawn from about 50 representative logs within each of 4 log grades should suffice.

Table 4. --Dry lumber yields for loblolly and shortleaf logs [1]

LOG GRADE I

Log d.i.b. (inches)	B&B	C	D and/or 1C	1D	2C	2D	3C	3D	4C	Mfg. loss	Logs
	Lumber grades										
	Percent										Number
17	22	7	14	15	16	11	8	4	1	2	23
18	24	7	14	14	16	10	8	4	1	2	20
19	25	8	14	12	17	9	8	4	1	2	14
20	25	8	15	12	17	8	8	4	1	2	5
21	26	8	15	10	18	7	9	4	1	2	8
22	27	8	16	9	19	6	9	3	1	2	8
23	28	8	16	7	20	5	10	3	1	2	3
24	29	8	17	6	20	4	10	3	1	2	0
25	30	8	17	4	21	3	11	3	1	2	0
26	32	9	17	2	21	2	11	3	1	2	1
Average	25	8	15	10	18	8	9	4	1	2	

LOG GRADE II

Log d.i.b. (inches)	B&B	C	D and/or 1C	1D	2C	2D	3C	3D	4C	Mfg. loss	Logs
10	22	8	15	20	13	11	4	4	1	2	21
11	21	8	15	20	14	11	4	4	1	2	15
12	20	8	15	20	14	11	5	4	1	2	32
13	20	8	15	20	14	11	5	4	1	2	19
14	19	7	15	20	15	11	6	4	1	2	41
15	19	7	15	19	15	11	7	4	1	2	32
16	19	7	15	19	15	11	7	4	1	2	36
17	19	7	15	19	15	11	7	4	1	2	10
18	18	7	15	18	16	11	8	4	1	2	7
19	18	7	15	18	17	10	8	4	1	2	6
20	18	7	14	17	18	10	9	4	1	2	3
21	18	7	14	17	18	10	9	4	1	2	0
22	17	6	14	17	19	10	10	4	1	2	2
23	17	6	14	16	19	10	10	4	2	2	0
24	16	6	14	16	20	10	10	4	2	2	2
Average	19	7	14	19	16	11	7	4	1	2	

[1] Based on curved data from 1956-1959 studies.

Table 4.--Dry lumber yields for loblolly and shortleaf logs [1] (continued)

LOG GRADE III

Log d.i.b. (inches)	Lumber grades										Logs
	B&B	C	D and/or 1C	1D	2C	2D	3C	3D [2]	4C	Mfg. loss	
	- - - - - - - - - - - - - - - - Percent - - - - - - - - - - - - - - - - -										Number
6	2	2	4	39	7	31	3	10	1	1	31
7	3	2	4	36	8	31	4	10	1	1	24
8	3	2	5	34	10	30	4	10	1	1	35
9	4	2	5	32	11	30	5	9	1	1	34
10	4	3	6	29	13	29	5	9	1	1	34
11	5	3	7	27	14	28	5	9	1	1	42
12	5	3	7	24	16	28	6	9	1	1	60
13	6	3	7	22	17	28	6	9	1	1	37
14	6	3	8	20	19	27	6	9	1	1	48
15	7	3	8	17	20	27	7	9	1	1	26
16	7	3	9	15	22	26	7	9	1	1	23
17	8	3	9	13	23	26	7	9	1	1	16
18	8	3	10	10	25	25	8	8	1	2	10
19	8	4	11	8	26	24	8	8	1	2	4
20	9	4	11	6	27	24	8	8	1	2	7
Average	7	3	8	19	19	27	6	9	1	1	

LOG GRADE IV

Log d.i.b. (inches)	B&B	C	D and/or 1C	1D	2C	2D	3C	3D	4C	Mfg. loss	Logs
6	2	1	4	8	19	37	7	20	1	1	23
7	2	1	4	8	20	36	7	20	1	1	31
8	2	1	4	7	20	36	8	20	1	1	57
9	2	1	4	7	20	35	9	20	1	1	66
10	2	1	4	6	20	34	10	20	2	1	68
11	2	1	4	6	21	34	10	19	2	1	47
12	2	1	4	6	21	33	11	19	2	1	34
13	2	1	4	6	21	32	12	19	2	1	42
14	2	1	4	5	21	32	12	19	3	1	28
15	2	1	4	4	22	31	13	19	3	1	21
16	2	1	4	4	22	30	14	19	3	1	23
17	2	1	4	4	22	29	15	19	3	1	5
18	2	1	4	3	23	29	15	19	3	1	10
19	2	1	4	3	23	28	16	18	4	1	2
20	2	1	4	3	23	27	17	18	4	1	12
Average	2	1	4	5	21	32	12	19	3	1	

[1] Based on curved data from 1956-1959 studies.
[2] Includes 1 percent 4D in grade III logs and 2 percent in grade IV logs.

OVERRUN

Overrun and underrun data were collected for the four major pine species during the 1956 and 1959 studies. Each of the 1,491 logs was carefully scaled by the Doyle, Scribner Decimal C, and International $\frac{1}{4}$-inch log rule. All logs were sawed on circular mills and the variations shown are based on green lumber tallied for each log. Only full scale (sound) log data are shown in table 5. The wide variation in overrun of the 190 defective logs militated against their inclusion in this table.

These data were analyzed separately by species, location, log grade, and size. Log size proved most important from the practical standpoint. The values shown in the table were derived from regression computations.

Many studies of overrun and underrun by different scales and log grades have been published in the past. Overrun is influenced far more by log scale than by log grade, but also at any one mill by the width and thickness of the product, the mill efficiency, and the ability of the sawyer.

Table 5. --Variations in some log scales compared with green lumber tally of southern yellow pine[1]

Log d.i.b. (inches)	Log rule			Logs
	Doyle	Scribner Decimal C	International $\frac{1}{4}$ inch	
	- - - - - - - - - - Percent - - - - - - - - - - - -			Number
6	+400	+28	-2	89
7	200	26	-2	102
8	130	23	-3	134
9	90	21	-3	162
10	70	19	-4	155
11	50	17	-4	132
12	42	14	-5	167
13	32	12	-5	119
14	26	10	-6	128
15	20	8	-6	85
16	16	5	-7	74
17	12	3	-8	43
18	8	1	-8	42
19	4	-2	-9	22
20	0	-4	-9	16
21	-2	-6	-10	8
22	-4	-8	-11	8
23	-6	-10	-11	3
24	-8	-13	-12	2
Total				1,491

[1] Results shown are based on green lumber tally of sound logs obtained from log grade studies in 1956 and 1959.

QUALITY INDEX

Quality index is a numerical expression indicating the value of a given log on a 1,000-board-foot basis in relation to the value of a base lumber grade. Quality index for southern pine was developed by L. R. Grosenbaugh in 1949 and first published in "Interim Log Grades for Southern Pine." The system was developed to take advantage of the reasonably constant relative price structure which prevailed from 1915 to 1949 (excepting World War II years). The original indices were based on the percentage relationship which various average item prices have borne to the price of a No. 2 common standard length 1" x 8" kiln dried S4S board. An adaptation is shown in table 6. That price qualified as the base because the volumes, values, and prices of other lumber items and grades had tended to bear steady relationships to the No. 2 common lumber. By means of these indices, a single value for each log can be calculated which is proportional to the average value per thousand board feet of green or dry lumber obtained from the log. For example, a log with a quality index (abbreviated Q. I.) value of 125 means that this log is worth 125/100 times the base lumber rate of a No. 2 common 8-inch board. If such a board is worth $80 per M bd. ft. on the market, a thousand board feet of logs such as the one mentioned above is worth $80 x 1.25, or $100.

Table 6. --Grade-width-thickness quality indices for shortleaf yellow pine lumber [1]

Nominal inches thickness	Grade	Nominal inches width				
		4	6	8	5 and 10	12
1	B&B	220	220	220	235	310
	C	180	180	180	200	245
	No. 1C	155	155	155	165	200
	No. 2C	85	100	100	100	115
	No. 3C	60	80	85	85	85
2	No. 1D	110	100	105	115	130
	No. 2D	110	90	95	110	110
	No. 3D	65	65	65	65	65

[1] Basis: 16 ft. length for dimension, standard lengths for others. KD and S4S for No. 2 or better material, AD and S4S for other material. Index base is No. 2 common 1" x 8" board price, equivalent to 100 in the above table. Lumber grades are those of the Southern Pine Inspection Bureau of the Southern Pine Association, New Orleans, Louisiana.

Table 7. --Quality indices based on 1958-59 southern yellow pine lumber prices [1]

Nominal inches thickness	Grade	Nominal inches width				
		4	6	8	10	12
1	B&B	165	170	175	180	210
	C	150	155	160	165	180
	D	120	130	140	150	160
	No. 1C	120	125	135	140	150
	No. 2C	90	100	100	100	110
	No. 3C	65	85	85	80	80
2	No. 1D	110	110	115	115	120
	No. 2D	100	100	105	110	115
	No. 3D	65	80	85	80	80

[1] Basis: 16 ft. length for dimension, standard lengths for others. KD and S4S for No. 2 or better material, AD and S4S for other material. Index base is No. 2 common 1" x 8" board price, equivalent to 100 in the above table. Lumber grades are those of the Southern Pine Inspection Bureau of the Southern Pine Association, New Orleans, Louisiana.

Q. I. thus becomes a useful research tool, since it makes possible a comparison of log values and log grades directly without stating the quantity of each grade of lumber included in the log. It also provides a tool for comparative analysis without necessity of the cumbrous process of computing the percent volume and value of each grade of lumber involved.

Probably the most valuable aspect of Q. I. is that it permits an appraiser to compare values at different locations or periods of time without being influenced unduly by the price variables involved.

There have been some real and varied price changes in southern pine since publication of the original indices. According to Row and Guttenberg (1962), the spread between the price of boards and dimension has been steadily narrowing since 1955. Furthermore, the price ratio of B&B lumber to No. 2 common boards has dropped approximately 18 percent, while the ratio between No. 2 dimension and No. 2 common has increased some 20 percent.

Meanwhile the sensitivity of quality index as a measuring tool has been somewhat dulled by the price erosion of the finished grades of lumber. This price change and the changed ratio of the dimension grades have raised questions about the usefulness of the first Q. I. table; hence the development and inclusion of a new table (table 7) based on lumber prices for the year 1958-1959. Only time will tell whether the new Q. I.'s will be as stable as the earlier ones. As of September 1963, they appeared sound. The average quality index by species, log grade, and size is listed in table 8, and illustrated in figure 2.

Table 8. --Quality index values

SLASH AND LONGLEAF

Log d.i.b. (inches)	Green lumber yields by log grade--				Dry lumber yields by log grade--			
	I	II	III	IV	I	II	III	IV
6	--	--	113	106	--	--	110	103
8	--	--	114	105	--	--	111	102
10	--	130	115	104	--	126	112	101
12	--	132	116	103	--	127	113	101
14	--	134	117	101	--	129	115	99
16	--	135	118	100	--	130	115	99
Average	--	132	116	103	--	128	113	101

SHORTLEAF AND LOBLOLLY

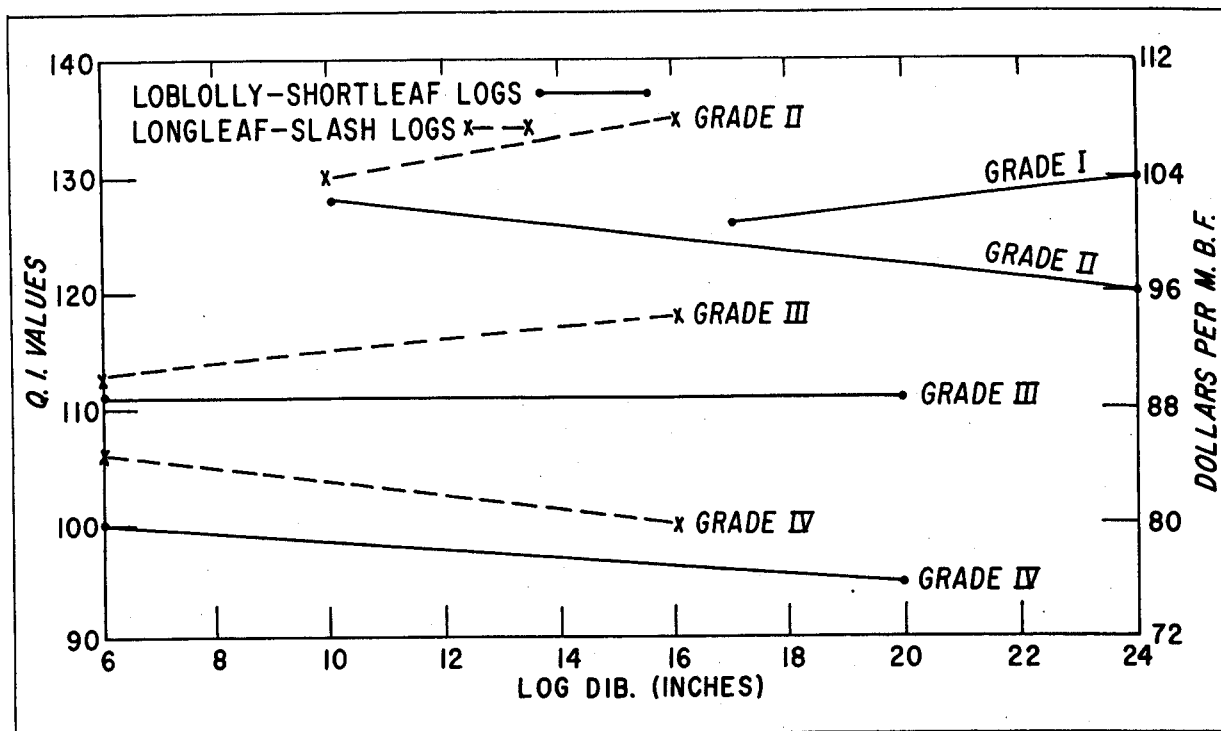| Log d.i.b. (inches)	Green lumber yields by log grade--				Dry lumber yields by log grade--			
	I	II	III	IV	I	II	III	IV
6	--	--	111	100	--	--	108	100
8	--	--	111	100	--	--	108	100
10	--	128	111	99	--	124	109	99
12	--	127	111	98	--	122	109	99
14	--	126	111	98	--	121	109	98
16	--	126	111	97	--	120	109	97
18	127	124	111	96	122	119	108	97
20	128	122	111	95	123	118	--	--
22	129	120	--	--	124	117	--	--
24	130	119	--	--	125	116	--	--
Average	127	124	111	97	123	120	109	98

Figure 2. --These curves show the effect of log size and grade on lumber values per M bd. ft. of sawed lumber. Note that values generally increase with log size in the case of slash-longleaf, whereas they generally decrease as size increases in the loblolly-shortleaf group. Based on 1958-1959 lumber prices.

Where local grade yields and prices are available, the local weighted values of a log or a group of logs can be computed. A sample log 13 inches in diameter by 16 feet long is illustrated as follows:

Grade	Thickness width (Inches)	Lumber tally (Bd. ft.)	Lumber value indices (from table 7)	Weighted indices
B&B	1 x 8	18.7	175	3,272
C	1 x 6	5.0	155	775
No. 2C	1 x 4	5.3	90	477
No. 1D	2 x 10	80.0	115	9,200
Total		109.0		13,724

Mill tally Q. I. for log $= \dfrac{13,724}{109} = 126$

Totaling the lumber tallies and weighted indices for the group of logs of a given log grade and dividing the index total by the tally total will give the average quality index for that log grade.

SUMMARY

This report combines some 30 years of southern yellow pine grade-yield research. The result is a log grading system for southern yellow pine yard lumber second to none in common use today. Over 10 years of continuously good performance in U. S. Forest Service work coupled with subsequent analyses and successful regional trials attest to this fact. This grading system is recommended to southern pine timber buyers, sellers, and processors.

This more complete publication supersedes the Interim Report issued by the U. S. Forest Service in 1953. Its purpose is basically the same--to explain and encourage the use of the now-standard Forest Service pine log grades.

In the study and application of these recommended log grades, it will be most helpful if this paper is used in conjunction with Station Paper 156, which illustrates and identifies most of the grading features specified.

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